

WHAT IS CLAIMED IS:

1. In an optical fiber communications system, a method for maintaining jitter tolerance of data transmitted across the communications system, the method comprising:
 - receiving a tributary complying with a jitter tolerance;
 - recovering data from the tributary;
 - receiving a reference clock;
 - generating at least two low-speed data channels, wherein the low-speed data channels in aggregate contain the recovered data and each low-speed data channel is timed by a clock based on the reference clock;
 - modulating each low-speed data channel to generate a corresponding low-speed symbol channel; and
 - frequency division multiplexing the low-speed symbol channels to produce an electrical high-speed channel for transmission in optical form across the communications system.
2. The method of claim 1 wherein the tributary and the jitter tolerance conform to a SONET protocol.
3. The method of claim 2 wherein each low-speed data channel includes:
 - a framing header and a data rate which conforms to the SONET protocol; and
 - a payload which does not conform to the SONET protocol.
4. The method of claim 3 wherein each low-speed data channel includes:
 - a framing header and a data rate which conforms to the STS-3 protocol; and
 - a payload which does not conform to the STS-3 protocol.
5. The method of claim 3 wherein each low-speed data channel includes:
 - a framing header and a data rate which conforms to the STS-48 protocol; and

3 a payload which does not conform to the STS-48 protocol.

1 6. The method of claim 1 wherein the step of generating the low-speed data channels
2 comprises:

3 recovering a clock from the tributary;

4 phase aligning the reference clock to the recovered clock;

5 retiming the recovered data using the phase-aligned reference clock; and

6 time division demultiplexing the retimed, recovered data into the low-speed data
7 channels.

8 7. The method of claim 6 wherein the step of time division demultiplexing the recovered
9 data into the low-speed data channels occurs in at least two stages.

10 8. The method of claim 1 further comprising:

11 converting the electrical high-speed channel to an optical high-speed channel;

12 transmitting the optical high-speed channel across a fiber;

13 receiving the optical high-speed channel;

14 converting the received optical high-speed channel to a receive-side electrical high-speed
15 channel;

16 frequency division demultiplexing the receive-side electrical high-speed channel into at
least two receive-side low-speed symbol channels;

demodulating each receive-side low-speed symbol channel to generate a corresponding
receive-side low-speed data channel;

recovering a clock and data from each receive-side low-speed data channel;

generating a receive-side reference clock synchronized to the receive-side recovered data;

and

generating a receive-side tributary, wherein the receive-side tributary contains all of the
receive-side recovered data, and the receive-side tributary is timed by a clock
based on the receive-side reference clock and complies with the jitter tolerance.

- 1 9. The method of claim 8 wherein the tributary, the receive-side tributary and the jitter
2 tolerance conform to a SONET protocol.
- 1 10. The method of claim 8 wherein the step of generating the receive-side tributary
2 comprises:
3 time division multiplexing the receive-side recovered data into the tributary.
- 1 11. The method of claim 10 wherein the step of time division multiplexing the receive-side
2 recovered data into the tributary comprises:
3 storing the recovered data from each receive-side low-speed data channel;
4 aligning a timing for the receive-side low-speed data channels; and
5 time division multiplexing the stored recovered data according to the aligned timing.
- 1 12. In an optical fiber communications system, a method for maintaining jitter tolerance of
2 data transmitted across the communications system, the method comprising:
3 receiving an electrical high-speed channel containing data transmitted across the
4 communications system, the data from a tributary complying with a jitter
5 tolerance before said transmission;
6 frequency division demultiplexing the electrical high-speed channel into at least two low-
7 speed symbol channels;
8 demodulating each low-speed symbol channel to generate a corresponding low-speed
9 data channel;
10 recovering data from each low-speed data channel;
11 generating a reference clock synchronized to the recovered data; and
12 generating a tributary, wherein the tributary contains all of the recovered data, and the
13 tributary is timed by a clock based on the reference clock and complies with the
14 jitter tolerance.

- 1 13. The method of claim 12 wherein the tributary and the jitter tolerance conform to a
2 SONET protocol.
- 1 14. The method of claim 13 wherein each low-speed data channel includes:
2 a framing header and a data rate which conforms to the SONET protocol; and
3 a payload which does not conform to the SONET protocol.
- 1 15. The method of claim 14 wherein each low-speed data channel includes:
2 a framing header and a data rate which conforms to the STS-3 protocol; and
3 a payload which does not conform to the STS-3 protocol.
- 1 16. The method of claim 14 wherein each low-speed data channel includes:
2 a framing header and a data rate which conforms to the STS-48 protocol; and
3 a payload which does not conform to the STS-48 protocol.
- 1 17. The method of claim 12 wherein the step of generating the tributary comprises:
2 time division multiplexing the recovered data into the tributary.
- 1 18. The method of claim 17 wherein the step of time division multiplexing the recovered data
2 into the tributary occurs in at least two stages.
- 1 19. The method of claim 17 wherein the step of time division multiplexing the recovered data
2 into the tributary comprises:
3 storing the recovered data from each low-speed data channel;
4 aligning a timing for the low-speed data channels; and
5 time division multiplexing the stored recovered data according to the aligned timing.
- 1 20. The method of claim 19 wherein the step of aligning a timing for the low-speed data
2 channels comprises:
3 generating a framing pulse for each low-speed data channel; and

aligning the framing pulses.

21. An optical fiber communications system for maintaining jitter tolerance of data transmitted across the communications system, the communications system comprising:

- a local oscillator for generating a reference clock conforming to a jitter tolerance;
- a clock and data recovery circuitry coupled to the local oscillator for recovering data from a received tributary and for retiming the recovered data according to the reference clock;
- a time division demultiplexer coupled to the clock and data recovery circuitry for time division demultiplexing the recovered data into at least two low-speed data channels, wherein each low-speed data channel is timed by a clock based on the reference clock;
- a modulator coupled to the time division demultiplexer for modulating each low-speed data channel to generate a corresponding low-speed symbol channel; and
- a frequency division multiplexer coupled to the modulator for frequency division multiplexing the low-speed symbol channels to produce an electrical high-speed channel for transmission in optical form across the communications system.

22. The communications system of claim 21 wherein the tributary and the jitter tolerance conform to a SONET protocol.

23. The communications system of claim 22 wherein each low-speed data channel includes:

- a framing header and a data rate which conforms to the SONET protocol; and
- a payload which does not conform to the SONET protocol.

24. The communications system of claim 23 wherein each low-speed data channel includes:

- a framing header and a data rate which conforms to the STS-3 protocol; and
- a payload which does not conform to the STS-3 protocol.

- 1 25. The communications system of claim 23 wherein each low-speed data channel includes:
2 a framing header and a data rate which conforms to the STS-48 protocol; and
3 a payload which does not conform to the STS-48 protocol.
- 1 26. The communications system of claim 21 wherein the time division demultiplexer
2 includes a multi-stage time division demultiplexer.
- 1 27. The communications system of claim 21 further comprising:
2 an E/O converter coupled to the frequency division multiplexer for converting the
3 electrical high-speed channel to an optical high-speed channel and for transmitting
4 the optical high-speed channel across a fiber;
5 an O/E converter for receiving the optical high-speed channel and for converting the
6 received optical high-speed channel to a receive-side electrical high-speed
7 channel;
8 a frequency division demultiplexer coupled to the O/E converter for frequency division
9 demultiplexing the receive-side electrical high-speed channel into at least two
10 receive-side low-speed symbol channels;
11 a demodulator coupled to the frequency division demultiplexer for demodulating each
12 receive-side low-speed symbol channel to generate a corresponding receive-side
13 low-speed data channel;
14 a receive-side data recovery circuitry coupled to the demodulator for recovering data from
15 each receive-side low-speed data channel;
16 a phase-locked loop coupled to the receive-side data recovery circuitry for generating a
17 receive-side reference clock synchronized to the receive-side recovered data; and
18 a time division multiplexer coupled to the receive-side data recovery circuitry and the
19 phase-locked loop for generating a receive-side tributary, wherein the receive-side
20 tributary contains all of the receive-side recovered data, and the receive-side

tributary is timed by a clock based on the receive-side reference clock and
complies with the jitter tolerance.

28. The communications system of claim 27 wherein the tributary, the receive-side tributary
and the jitter tolerance conform to a SONET protocol.

29. The communications system of claim 27 wherein the time-division multiplexer
comprises:

a state machine for aligning a timing for the receive-side low-speed data channels;
buffers for storing the recovered data from each receive-side low-speed data channel and
releasing the stored recovered data according to the aligned timing; and
multiplexers for combining the released data.

30. An optical fiber communications system for maintaining jitter tolerance of data
transmitted across the communications system, the communications system comprising:

a receiver for receiving an electrical high-speed channel containing data transmitted
across the communications system, the data from a tributary complying with a
jitter tolerance before said transmission;

a frequency division demultiplexer coupled to the receiver for frequency division
demultiplexing the electrical high-speed channel into at least two low-speed
symbol channels;

a demodulator coupled to the frequency division demultiplexer for demodulating each
low-speed symbol channel to generate a corresponding low-speed data channel;
a clock and data recovery circuitry coupled to the demodulator for recovering data from
each low-speed data channel and for generating a reference clock synchronized to
the recovered data; and

a time division multiplexer coupled to the clock and data recovery circuitry for generating
a tributary, wherein the tributary contains all of the recovered data, and the

tributary is timed by a clock based on the reference clock and complies with the jitter tolerance.

31. The communications system of claim 30 wherein the tributary and the jitter tolerance conform to a SONET protocol.

32. The communications system of claim 31 wherein each low-speed data channel includes: a framing header and a data rate which conforms to the SONET protocol; and a payload which does not conform to the SONET protocol.

33. The communications system of claim 32 wherein each low-speed data channel includes: a framing header and a data rate which conforms to the STS-3 protocol; and a payload which does not conform to the STS-3 protocol.

34. The communications system of claim 32 wherein each low-speed data channel includes: a framing header and a data rate which conforms to the STS-48 protocol; and a payload which does not conform to the STS-48 protocol.

35. The communications system of claim 30 wherein the time division multiplexer comprises a multi-stage time division multiplexer.

36. The communications system of claim 30 wherein the time division multiplexer comprises:

a state machine for aligning a timing for the receive-side low-speed data channels; buffers for storing the recovered data from each receive-side low-speed data channel and releasing the stored recovered data according to the aligned timing; and multiplexers for combining the released data.